

which leads up by easy gradations through both sexes of various species of *Perrhybris* (another Pierine genus) to the red, black, and yellow Müllerian assemblage we have already considered. From an intermediate stage in this latter series, exemplified on the undersurface of *Perrhybris lorena* ♀, we get a passage to yet another Heliconiine scheme of coloration, that shown by *H. aranea*. Here, then, we have groups centring round protected Heliconiines and Ithomiines of the most varied aspects, all held together and linked up with white butterflies of the ordinary Pierine facies by a network of almost imperceptible gradations.

As a final illustration, let me direct your attention to the series formed by *Papilio iphidamas* ♀, *Euterpe approximata*, *E. bellona*, *E. nigrina* (underside), and *Heliconius venusta*.

We have only to examine a gradated series like this to see how difficult it is to account for it on Batesian lines. There is the common aposeme, the yellow patch on the dark forewing, running right through; but if the *Papilio* is the model for all the rest, why should these *Euterpes*, which are Pierines, mimic a mimic (the *Heliconius*) instead of going to the model itself (the *Papilio*)? If, on the other hand, we regard the *Heliconius* as the model, we are met by exactly the same difficulty, only that it is reversed. Now we know that some at least of these intermediate forms are numerous in individuals, and as soon as the Müllerian principle is admitted we can see how easily forms protected by distastefulness can arrange themselves into a gradational series of this kind. For every distasteful form tends to protect other forms on each side of itself; hence the existence of these transitional stages is just what we should expect. This group represents in miniature what is everywhere to be found when we examine a tropical butterfly fauna from the point of view of mimicry, and I think we have here discovered the answer to an objection that met us at the outset, namely, the difficulty of accounting, on the principle of natural selection, for the existence of these intermediate forms, including the initial mimetic stages. Whether or no the difficulty is a real one in the way of the Batesian theory, in view of the Müllerian principle it is non-existent.

The comparison may perhaps be allowed between these mimetic groups, each with its own type of coloration, and the solar and stellar systems. Sometimes, as in the solar system, there is one central member of the group dominating the whole and influencing its attendant planets to an extent in comparison with which the force they themselves can exercise is insignificant. At other times, as in the systems of double and multiple stars, there are bodies more nearly equal in mass and importance bound together by mutual attraction into a single combination, where each one effectively controls and is controlled by the rest. Could we imagine irregular wanderers through cosmic space which from time to time get drawn within the limits of some established system, we might in them find an analogy to certain species which seem to hover on the outskirts of mimetic groups, undecided, as it were, whether to throw in their lot with one association or another.

What result have we been able to reach to-night? Starting from the fact, long recognised by naturalists, of the wonderful likeness borne to each other by certain insects of widely different affinities, we have found that the first rational explanation of the phenomenon was given by Bates, who nevertheless did not conceal from himself that his interpretation left many of the observed facts unaccounted for. The fertile suggestion of Fritz Müller went far to supply what was still wanting. Expanded by Meldola and by Poulton, accepted by travelled naturalists like Wallace and Trimen, the Müllerian generalisation has proved a powerful means of interpretation of many complicated relationships. We have seen reason for concluding that such rival attempts at explanation as those which allege affinity, or geographical and climatic conditions, as adequate causes for the phenomena before us, break down on serious examination; and we have applied the final test of arguing deductively from the premises, and finding, on a fresh appeal to the facts, that our results are in accordance with expectation.

This verification, we saw, is concerned with the three chief topics of (1) the interchange of characters, or diaposematism; (2) the influencing of subordinate members of mimetic groups by one another; and (3) the nexus of protected conspicuous forms which may overspread a whole zoological continent.

I think no one who has paid attention to the facts that have been before us can fail to recognise that here, as everywhere in organised nature, the principle of adaptation is paramount. No scientific explanation of adaptation that really meets the case has yet been offered except natural selection. Whatever bearing the principle of adaptation by selection may have on the question of the origin of species—I for one venture to think that it has a very important bearing—it is a principle which cannot in fairness be ignored.

In what has been said I have tried to be explanatory rather than controversial, though it has not been possible to avoid altogether points that have given occasion for dispute. Those who are conversant with the subject will know that many questions of interest have been left unnoticed; but I trust that in this survey, necessarily brief, I have said enough to show how much of biological importance and interest is involved in the really great subject of mimicry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. C. Punnett has been re-elected to the Balfour studentship for one year from Michaelmas, 1907.

A grant of 50*l.* from the Balfour fund has been made to Mr. W. E. Agar in furtherance of his expedition to the Paraguayan Chaco.

A proposed change in the Previous Examination, which may be of far-reaching importance, will be voted on by the Senate next week. At the suggestion of the Board of Examinations, a paper on elementary heat and chemistry will be put in part ii. of the Previous Examination as an alternative to the papers on Paley's "Evidences" and elementary logic. The Board also proposes the substitution of a single combined paper on arithmetic and algebra for the present separate papers on these subjects in the same examination.

The Special Board for Mathematics has issued an important report with reference to the constitution of the board. Owing to the new regulations, the examiners and moderators will in future be nominated by the board. The representatives of the college on the board given them in past years by the nomination of the moderators will thus disappear. The board considers it advisable that there should be direct representation of the mathematical lecturers of the University and of the colleges; it is therefore suggested that two members be nominated each year at a meeting held of the lecturers in subjects for the mathematical tripos.

The reforms which the board of mathematics have introduced into the University in the last four years are numerous and far-reaching. They include a complete revision of the mathematical tripos, the recognition that the teaching of mathematics should be correlated with that of physics and engineering, the establishment of a qualifying examination in mechanical sciences, re-casting of the mechanical sciences tripos, and reforms in the mathematical special examination for the ordinary degree.

Dr. Hobson has been re-elected president of the Cambridge Philosophical Society. The new vice-presidents are Prof. J. J. Thomson and Mr. S. Ruhemann. The new members of the council are Prof. T. B. Wood, Prof. B. Hopkinson, Dr. Searle, and Mr. W. E. Dickson. Mr. H. F. Newall has been re-elected treasurer, and Mr. A. E. Shipley, Dr. E. W. Barnes, and Mr. P. V. Bevan secretaries.

OXFORD.—The Romanes lecture will be delivered by the Chancellor of the University, Lord Curzon, All Souls' College, on Saturday, November 2, at 2.30, in the Sheldonian Theatre. The subject of the lecture will be "Frontiers."

Mr. J. S. C. Douglas, Christ Church, Radcliffe travelling fellow, has been elected to the Philip Walker studentship in pathology.

THE London Day Training College, Southampton Row, W.C., will be opened by the Earl of Rosebery on Saturday, November 2, at 3 p.m. The ceremony will be conducted by Mr. H. Percy Harris, chairman of the London County Council.

DR. W. GOODWIN has been appointed head of the chemical department of the South-Eastern Agricultural College (University of London), and Mr. B. N. Wall head of the agricultural department. A new department of soil bacteriology is being established under the charge of Mr. C. T. Gimmingham. A conference of hop-growers will be held on November 27 under the chairmanship of Mr. E. C. Lister-Kay, when papers on fertilisation of hops, eel-worms, and hop-drying will be communicated.

At the annual general meeting of the Old Students' Association at University College (University of London), Dr. Tempest Anderson was elected president of the association for the year 1907-8. The annual dinner of the association will be held on Thursday, December 5. The new wing that has recently been added to the college will be completed by that time, and will be open to inspection. Former students of the college who desire to be present should communicate with Mr. George A. Aitken at 42 Edwardes Square, Kensington, W.

PROF. L. F. VERNON HARCOURT, who died on September 14, bequeathed 1000*l.* to the Institution of Civil Engineers in memory of the many advantages he had derived from its library and lectures, to found a yearly or biennial (in the discretion of the institution) lecture, medal, premium, or prize, in connection with river, canal, or maritime engineering. The residue of his property he left to his wife for life, and after her death to the University of Oxford, if there shall have been founded there in the lifetime of himself and his wife a school of engineering or mechanical science, 1000*l.* for the promotion of the teaching of engineering science there. He also bequeathed 200*l.* to University College, London, for a yearly prize in civil engineering.

THE new laboratories of the scientific departments of the College of Liberal Arts of Boston University have now been opened in the building formerly occupied by the Harvard Medical School. We learn from *Science* that the top floor is occupied by the departments of astronomy, physics, and mathematics, and comprises large and small lecture-rooms, laboratories, and offices; a large part of the basement is also given over to physics. The chemical and biological departments occupy the second floor, and consist of large, well-lighted class laboratories, private laboratories and store-rooms, professors' rooms, and an amphitheatre for the larger classes. The two domes for the telescopes of the astronomical department are situated on the roof, and are not quite completed. The equipment of all the laboratories is new, and was purchased in part by special funds given to the University for that purpose. The scientific departments are under the same directors as last year.

THE report for the year 1907 on secondary education in Scotland, prepared by Dr. J. Struthers, the permanent secretary of the Scotch Education Department, has just been published. It appears that instruction in experimental science continues to make headway steadily. The schemes of study submitted to the department for approval often show a tendency to attempt a larger volume of work than can be accomplished satisfactorily in the time allotted to the subject, and teachers find difficulty in treating inductively the more advanced subjects included in the school course of physics and chemistry. The chief examiner reports a large increase in the number of candidates presented at the examination for leaving certificates. It is exceedingly satisfactory, the report continues, to know that in more than 50 per cent. of the schools the examiners were able to accept the teacher's list without change or modification of any kind. This is a sure sign of the growth of that mutual confidence between teachers and examiners which is essential to any really healthy system of examination.

THE scientific training of the pharmacist was the subject chosen by Prof. Meldola, F.R.S., for the inaugural address upon the occasion of the opening of the present winter session of the School of Pharmacy. From the lecture we gather that for the two examinations of the school the passing of which qualify the student as a pharmacist, a period of fifteen months' training is all that is required. The standard of the examinations themselves is unquestionably high, and too high, in the opinion of Prof. Meldola, for so short a period of training, creating the danger of the instruction of the school degenerating into a "cram." It appears, however, that at present no knowledge of the action of drugs is demanded of the pharmacy student, although a most intimate acquaintance with the methods of physical and chemical analysis is demanded of him. There can be no doubt that legally great responsibility rests upon the pharmacist, in that if he cannot make his own preparations he is expected to know how they are made and how to assure himself that the products he dispenses are of the nature and substance demanded. In Germany a more thorough and a more prolonged scientific training is necessary before a legal qualification in pharmacy can be obtained, and in this country certain universities have, after a prolonged and thorough curriculum, granted degrees in pharmacy. In conclusion, Prof. Meldola suggested that the Pharmaceutical Society should demand of those students entering the school a higher standard of general education and some specific scientific training either in addition to or in the place of the present three years' apprenticeship, or, in other words, that more attention should be given to the scientific status of pharmacy, even if this has to be done at the expense of its commercial aspects.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 21.—M. H. Becquerel in the chair.—The transits of Mercury across the sun, and in particular on that of November 14: G. Bigourdan. A discussion of the various phenomena which have been observed in connection with the transits of Mercury, together with suggestions regarding instruments, &c., for use in the coming transit.—Some formulæ relating to the minima of classes of quadratic forms, binary and positive: G. Humbert.—The spawning of the cod in the south of the North Sea: Alfred Giard and C. Cépède. The authors criticise the views put forward by T. Wemyss Fulton in a recent paper on the same subject. The spawning of the cod in the Pas-de-Calais, the south of the North Sea, and the Baltic takes place in winter, the maximum being produced towards the middle of February, or a month earlier than indicated by Fulton. There is no indication of there being two spawning seasons in certain localities.—The installation of a large astronomical instrument at the summit of the Pic du Midi: B. Baillaud. This was carried out in 1906 and 1907 with the assistance of officers and men of the French artillery. Observations will be commenced in August, 1908.—Observation of the Mellish comet (1907e) made with the bent equatorial of the Observatory of Lyons: J. Guillaume. The comet appeared on October 17 as a diffuse nebulosity of about 35" diameter, with a faint central nucleus. Its lustre is about that of a star of the tenth magnitude. The apparent positions of the comet and comparison stars are given.—Observations of the new comet (1907e) made at the Observatory of Marseilles with the Eichens 26 cm. equatorial: M. Borrelly. Similar observations made on October 17 and 18.—Integral equations: E. Goursat.—The integrals of the differential equation $y' + A_2y^2 + A_3y^3 = 0$: Pierre Bouteux.—The variation of the mass of the electrons in the interior of the atom: H. Pellat.—The formation and preparation of aluminium carbide: Camille Matignon. Four methods of preparing this carbide without the use of the electric furnace are described: heating a mixture of aluminium powder and lampblack in a Perrot gas furnace for twenty minutes, inducing the reaction to start at a point in the same mixture by the addition of iodine or sulphur, the use of the oxy-acetylene blow-pipe, and by the interaction of aluminium and hexachlorobenzene. In the first two cases the purity of the product was tested